TOOL BIT ASSEMBLY WITH OFFSET TOOTH

Background

The present invention relates to impact-type cutting tools used to pulverize and displace road construction materials, aggregate, earth strata, or the like. In particular, the present invention relates to a rotatably mounted tool bit and assembly for use in such impact-type cutting tools, wherein tool bit life is improved and tool bit change-out time is reduced.

Impact-type cutting tools are used in such operations as road recycling, trenching, boring and other mining and road construction operations. The cutting tools generally operate by driving a plurality of cutting tool bits into a surface to but cut/pulverized. A cutting tool bit may be driven by a variety of mechanisms including rotary drum drives, rotary wheel drives, chain drives, augers or others. Regardless of the drive mechanisms employed, a particular cutting tool bit cuts through the aggregate or similar material by impacting a hard cutting tooth of the cutting tool bit on the surface to be cut/pulverized. Commonly, the cutting tool bit is disposed within a mounting block pocket of a particular drive mechanism such that a portion of the bit including the tooth is free to rotate relative to the mounting block pocket. The resultant force of the impact of the cutting tooth on the cutting surface translates into tool bit rotation relative to the mounting block pocket and consequently, rotation of the cutting tooth. Rotation of the cutting tooth is preferable as more uniform tooth wear is sustained during cutting. It is generally recognized that more uniform tooth wear greatly extends the working life of the tooth. As working life is increased, less tool bit change-outs are necessary, thus decreasing time and cost associated bit change-outs.

Unfortunately, it is often the case that the pulverized particulate or other material is forced between an interface of a cutting tool bit and the mounting block pocket the bit is disposed in. At least two issues arise from the forced introduction

of foreign matter into such interfaces. First, rotation of a cutting tool bit relative to the mounting block pocket might be interfered with or arrested, thereby greatly accelerating localized tooth wear. Second, the foreign matter might build up in such a manner as to eject the bit from the mounting block pocket. The second issue can also arise when the tool bit contacts alternating soft and hard cutting surfaces. The impulse force on the tooth and bit can cause either the bit or even the tooth itself to eject or "kick" out of place during operation. Regardless of whether ejection is caused by particulate build-up or varying cutting surface hardness, the extreme forces on the tool bit while displaced can cause tool bit damage or even failure.

In an attempt to improve bit rotation and reduce kick out, cutting tool bits of prior design have incorporated retaining clips or other means to promote tighter contact between a bit and a mounting block pocket in order to reduce particulate ingression. These clips have been further modified to include "bowed" or spring designs, which seek to dampen transverse impulse forces. For examples of "springs" and "spring clip" designs, see U.S. Patent Nos. 4,247,150 and 5,018,793. Regrettably, particulate and foreign material along with the impulse forces hereinto described continue to plague the proper operation of cutting tool bits. Additionally, clips of prior design fail to provide a proper grasping surface or similar feature for removal of the clip during tool bit change-out. In this manner, the clips of prior design can be difficult to remove, thereby adding to tool bit change-out time and reducing overall process efficiency.

As a result, a need exists for a rotatable cutting tool bit assembly that promotes tooth rotation, resists ejection of a tool bit from a corresponding mounting block pocket, and is amenable to tool bit change-out from the mounting block pocket.

Summary

One aspect of the present invention relates to a rotatable cutting tool bit for use with impact-type aggregate cutting tools. In one embodiment, the tool bit comprises a cylindrical shank defining a central longitudinal axis, a bit head

connected to the shank and having a mouth opposite the shank, and a cutting tooth mounted within the mouth of the bit head such that the cutting tooth defines a central longitudinal axis. In the preferred embodiment, the central longitudinal axis of the cutting tooth is both parallel to and at an offset from the central longitudinal axis of the shank.

Another aspect of the present invention relates to a bit assembly of a rotating aggregate cutting machine comprising a mounting block pocket for use with a rotating aggregate cutting machine and a corresponding cutting tool bit. In a preferred embodiment, the mounting block pocket includes a cylindrical passage, in which the tool bit is disposed. The tool bit includes a cylindrical shank defining a leading section and a trailing section, a bit head connected to the leading section of the shank, and a cutting tooth disposed in the bit head. Further, the cutting tooth is preferably free to rotate relative to the mounting block pocket about an axis of rotation. In a preferred embodiment, the ability to rotate is accomplished as the shank of the cutting tool bit is rotatably and transversely secured within the mounting block pocket.

In another preferred embodiment, the shank is transversely secured via a clip captured within a clip groove formed in the trailing section of the shank. The clip preferably includes a generally annular body defining an open end and a closed end opposite the open end. Further, the closed end forms a sidewall extending from the annular body for grasping and removing the clip. In a related embodiment, a central longitudinal axis of the cutting tooth is offset from the axis of rotation of the cutting tooth. As will be described further in the Detailed Description, this offset promotes tooth rotation, thereby improving tooth life during a cutting operation.

Yet another aspect of the present invention relates to a method of un-assembling a rotatable bit from a mounting block pocket of an impact-type aggregate cutting machine. The method generally comprises of the steps of: Providing a mounting block pocket for use with an impact-type aggregate cutting machine; Providing a cutting tool bit disposed within the mounting block pocket;

Providing a clip captured within a clip groove formed in the cutting tool bit shank; Removing the clip by grasping a sidewall of the clip; and finally, Removing the tool bit from the mounting block pocket. In this manner, the clip may be more readily removed from the tool bit shank as a grasping surface is specifically provided for clip removal.

By at least the above stated means, the present invention promotes tooth rotation, resists ejection of a tool bit from a corresponding mounting block pocket, and is amenable to tool bit change-out from the mounting block pocket. In short, the present invention embodies a bit assembly having longer cutting tooth life, operating more reliably, and requiring shorter tool bit change-out times. A more detailed description of the invention and its preferred embodiments is presented below.

Brief Description of the Drawings

The invention will be further described with reference to the drawing wherein corresponding reference characters indicate corresponding parts throughout the several views of the drawing, and wherein:

FIG. 1 is a side view illustration, with portions shown in cross-section, of a bit assembly in accordance with the present invention for use with a rotating aggregate cutting machine.

FIG. 2 depicts an exploded view of the bit assembly of a rotating aggregate cutting machine of FIG. 1.

FIG. 3 shows a clip having a sidewall for use with the bit assembly of FIG. 1.

FIG. 4 illustrates an alternative embodiment bit assembly in accordance with the present invention.

Detailed Description

In the following Detailed Description, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. In this regard, directional terminology, such as "top," "bottom," "front," "back," "leading," "trailing," etc., is used with reference to the orientation of the FIGS. being described. Because components of embodiments of the present invention can be positioned in a number of different orientations, the directional terminology is used for purposes of illustration and is in no way limiting. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims.

A preferred embodiment of a tool bit assembly 10 in accordance with the present invention is shown in FIG. 1. The tool bit assembly 10 includes a tool bit 12 and a mounting block pocket 14 (shown in cross-section). The tool bit 12 can be generally described as including a cylindrical shank 16, a bit head 18 connected to the shank 16, and a hard cutting tooth 20 disposed in the bit head 18. A preferred embodiment of the tool bit assembly 10 also includes a wear sleeve 22 and a clip 24. Components of the tool bit assembly 10 are described in greater detail below. In general terms, however, the sleeve 22 is positioned over the shank 16, with the shank 16/sleeve 22 being mounted within the mounting block pocket 14 and maintained therein by the clip 24.

The mounting block pocket 14 (shown in cross-section) is illustrated more clearly in FIG. 2 and can be of a type commonly known in the art. The mounting block pocket 14 includes a passage 26, wherein the passage 26 extends through the mounting block pocket 14 from a first open end 28 to a second open end 30. In an alternative embodiment, the passage 26 can include grooves or other features for

lubricant or the like, as such features are well known to those of ordinary skill in the art.

In a preferred embodiment, the mounting block pocket 14 is constructed of materials and to dimensions that are well known to those of ordinary skill in the art. Such mounting block pockets are readily available from a number of sources, including Fansteel VR/Wesson-Lexington of Lexington, KY. In one preferred embodiment, the mounting block pocket 14 incorporates an industry standard, 0.780-inch diameter passage 26.

The tool bit 12 is illustrated in greater detail in FIG. 2, and again includes the shank 16, the bit head 18, and the tooth 20. The shank 16 forms a cylindrical shape having a central longitudinal axis (also referred to as "shank axis") x. With the one embodiment of FIG. 2, the shank 16 defines a leading section 34 and a trailing section 36. The leading section 34 is connected to the bit head 18 while the trailing section 36 forms an annular clip groove 38 in an exterior surface of the shank 16. In one preferred embodiment, the trailing section 36 of the shank 16 defines a larger diameter than an adjacent portion of the shank 16.

In a preferred embodiment, the shank 16 is 2.2 ± 0.005 inches long and 0.375 ± 0.005 inches in diameter at the leading section 34; the trailing section 36 is 0.750 ± 0.005 inches in diameter; the clip groove 38 is 0.187 ± 0.005 inches in width and in depth; and the sleeve 22 is 0.685 ± 0.005 inches in diameter. While a preferred embodiment has been described incorporating the above-detailed dimensions and materials, it is intended that upon reading this Specification, one having ordinary skill in the art would recognize that a variety of shank 16 dimensions and materials suitable for the impact-type cutting tool bit assembly 10 are included within the scope of the present invention. For example, in one embodiment, the shank 16 is formed of steel.

With the embodiment of FIG. 2, the bit head 18 forms a crown 42 and a shoulder 48. The crown 42 has a central longitudinal axis (also referred to as "crown axis") b. The crown 42 also forms a mouth 52 (shown by dotted lines),

opposite the shoulder 48, the mouth 52 having a central longitudinal axis (also referred to as "mouth axis") d. The mouth 52 can be generally described as a cavity sized to accept the cutting tooth 20 (described below). As depicted in FIG. 2, the shoulder 48 extends from the leading section 34 of the shank 16 and defines a central longitudinal axis (also referred to as "shoulder axis") c. In a preferred embodiment, the crown 42 defines a taper from the shoulder 48 toward the mouth 52. In other embodiments, the bit head 18, including the crown 42 and the shoulder 48, incorporate alternative or multiple diameters, tapers, or other features.

In a preferred embodiment, and in contrast to tool bits known in the art, the crown axis b is parallel to and at an offset from the shoulder axis c. Furthermore, the mouth axis d is coaxial to the crown axis b. As a result of these relative positions, the mouth axis d is also parallel to and offset from the shoulder axis c.

With the embodiment of FIG. 2, the shoulder 48 has a diameter in the range of 1.0 – 2.0 inches, more preferably in the range of 1.5 – 1.75 inches, even more preferably approximately 1.5 inches. Additionally, the bit head 18 preferably tapers in diameter 0.3 – 1.0 inch along a length thereof. The mouth 52 is preferably sized to accept a bullet nose cutting tooth 20 (available from Fansteel VR/Wesson-Lexington of Lexington, KY). In one embodiment, the bit head 18 includes a lateral offset in the range of 0.040 – 0.080 inch, more preferably 0.050 – 0.070 inch, and even more preferably 0.055 – 0.065 inch between the crown axis b and the shoulder axis c. In one embodiment, the lateral offset is not less than 0.03 inch. In another embodiment, the lateral offset is approximately 0.06 inch. While a preferred embodiment has been described incorporating the above-detailed dimensions, it is intended that upon reading this Specification, one having ordinary skill in the art would recognize that changes may be made to the above-described bit head dimensions and materials without departing from the scope of the present invention.

As illustrated in FIG. 2, the cutting tooth 20 preferably forms a base 56 and a nose 58 and has a central longitudinal axis (also referred to as "tooth axis") e. Additionally, the nose 58 forms an impact surface 62. Those of ordinary skill in the

art generally refer to the tooth 20 as a bullet nose tooth (available from Fansteel VR/Wesson-Lexington of Lexington, KY). The tooth 20 is preferably formed of tungsten carbide, but can include a variety of materials suitable for aggregate cutting operations. Upon reading and understanding this disclosure, one of ordinary skill in the art would recognize that a variety of tooth designs are appropriately within the scope of the present invention.

Spring sleeves or wear sleeves are commonly used to protect tool bit shanks from wear. With the preferred embodiment of FIG. 1, the wear sleeve 22 covers a portion of the shank 16. In one embodiment, the wear sleeve 22 is a generally tubular lumen having a slit 39, through its thickness, the slit 39 running the length of the wear sleeve 22. Such sleeves are well known in the art and are available from a variety of sources.

With additional reference to FIG. 3, the clip 24 preferably includes a clip body 69 and a sidewall 68. The clip body 69 is annular in shape having an open end 64 and a closed end 66. The open end 64 preferably includes a gap in the clip body 69, but may alternatively be formed by overlapping sections of the clip body 69 which may be forced open to create a gap. In preferred embodiments, the clip 24 includes the sidewall 68 to aid in grasping the clip 24. With the embodiment of FIG. 3, the sidewall 68, preferably located at the closed end 66, is generally arcuate in shape, conforming to the overall annular shape of a clip body 69.

The sidewall 68 can alternatively incorporate a variety of shapes including flat planes, multiple radii splines, or others. Additionally, the sidewall 68 is preferably located nearer the closed end 66 than the open end 64. In a preferred embodiment, the clip body 69 is generally planar in a Z-plane with the sidewall 68 extending generally perpendicular to the clip body 69. In an alternative embodiment, the clip body 69 is generally arcuate in a Z-plane. In yet another embodiment, the sidewall 68 extends at a non-perpendicular angle from the clip body 69. In a preferred embodiment, the clip 24 defines an inner diameter approximately matching that of the clip groove 38. Additionally, the sidewall 68

preferably extends at least 0.1 inch, more preferably at least 0.25 inch from the clip body 69. Upon reading this disclosure, one having ordinary skill in the art would recognize that the clip 24 could define a variety of inner diameters corresponding to a variety of different clip groove 38 (FIG. 2) diameters. Further, the clip body 69 can take a variety of shapes including, but not limited to pretzel shapes (or other such shapes with overlapping ends), square shapes, triangle shapes, and others.

The interrelation of the tool bit assembly 10 components can be described more clearly by returning to the preferred embodiment of FIG. 1. In a preferred tool bit assembly 10, the cutting tooth 20 is disposed within the mouth 52 (hidden in FIG. 1, but see FIG. 2) of the crown 42 of the bit head 18. In the preferred configuration, the tooth axis e is coaxial to the mouth axis d, which is in turn coaxial with the crown axis b. Further, the crown 42 and the shoulder 48 of the bit head 18 are connected together and the shoulder 48 is in turn connected to the first end 34 of the shank 16. Additionally, the shank 16 and shoulder 48 are preferably connected together such that the shank axis x and shoulder axis c are coaxial. In this manner, the cutting tooth 20 (otherwise mounted within the mouth 52) is offset from the shank axis x. The effect of the offset described above and alternative axes offsets, and combinations thereof, which are encompassed within the scope of the present invention, are described in further detail below.

The shank 16 is preferably secured within the mounting block pocket passage 26 such that the second end 36 of the shank 16, including the clip groove 38 (partially covered in FIG. 1, but see FIG. 2), protrudes from the second end 30 of the passage 26. Further, in a preferred embodiment, the shoulder 48 of the bit head 18 contacts the first end 28 of the passage 26. A virtual gap between interfaces is shown in FIG. 1 to allow illustration of the interface surfaces. It is to be noted that the contact may be selective, continuous, or combinations thereof. As previously described, the wear sleeve 22 can be disposed over the portion of the shank 16 that is secured within the mounting block pocket 14. With the embodiment of FIG. 1, the clip 24 is captured within the clip groove 38 (FIG. 2) of the shank 16 such that

the sidewall 66 of the clip 24 extends in a direction away from the mounting block 14. Further, the clip body 69 preferably contacts the second end 30 of the passage 26. It is to be noted that this contact may also be selective, continuous, or combinations thereof.

As will be described in greater detail below, the above assembly allows the tool bit 12 to rotate, and in fact, promotes rotation of the tool bit 12, within the pocket 14 while being transversely retained within the mounting block pocket 14. This, in turn, results in rotation of the cutting tooth 20 relative to the mounting block pocket 14. Rotation of the cutting tooth 20 is important as the extreme forces associated with cutting operations can lead to a relatively short tooth life. Rotation generally promotes more consistent wearing of the tooth 20, and in particular, consistent wearing of the impact surface 62 of the tooth 20.

One means by which the current invention improves rotation of the tool bit 12 can be described with reference to FIG. 1. The tool bit 12, and particularly the impact surface 62 of the cutting tooth 20, is caused to impact the strata or aggregate S by imparting a drive force F on the mounting block pocket 14. The drive force F is shown curved for illustrative purposes of the travel path of the tool bit assembly 10 only as many common drive mechanisms are rotary in nature. It is to be recognized that the drive force F is more accurately depicted with reference to a linear vector.

It is well known to those of ordinary skill in the art that tool bits of prior design will rotate to some degree upon impacting a cutting tooth with aggregate or strata. Contrary to prior art, it has been surprisingly found that improved rotation of the cutting tooth 20 is accomplished by laterally offsetting the tooth axis e from an axis of rotation W of the tooth 20. In a preferred embodiment, the shank 16 rotates within the mounting block pocket 14 thus defining an axis of rotation W of the tooth 20 relative to the mounting block pocket 14. Because the tool bit 12 rotates about the shank axis x, and the tooth axis e is laterally offset from the shank axis x, the tooth axis e is laterally offset from the axis of rotation W of the tooth 20. Rotation

of the tooth 20 relative the mounting block pocket 14 is promoted because the tooth 20 is able to partially, laterally deflect away from the relatively harder strata or aggregate S it encounters during cutting. In other words, the tooth is able to move laterally with respect to the axis of rotation W. For example, over a one-hundred and eighty degree turn, the tooth 20 laterally deflects twice the distance of its offset from the axis of rotation W. The lateral deflection produces a moment M that results in the forced rotation of the tool bit 12. It should be noted that a similar moment might also be generated by centrifugal forces resulting from the drive force F. In fact, a tooth 20 that has been offset too much from the axis of rotation W can become overly susceptible to centrifugal forces and thereby cease to rotate.

Surprisingly, if properly offset, not only does the forced lateral deflection of the tooth 20 improve rotation, the lateral deflection also dampens the transverse impulse forces on the tool bit 12 during cutting. As previously mentioned, transverse impulse forces can result in bit failure by causing the bit 12 or tooth 20 to eject or "kick" out. An offset tooth 20 is able to absorb some of the transverse force by laterally deflecting away from the harder strata. Equally surprising, it has been found that the forced rotation of the shank 16 causes foreign material and particulate to be displaced away from the tool bit 12 and mounting block 14 interface, further improving and ensuring tool bit 12 rotation. Thus, an offset between the tooth axis 60 and the axis of rotation W decreases tooth wear and increases time between bit change-outs.

Although, in a preferred embodiment, the axis of rotation W is defined by the rotation of the shank 16 within the passage 26, alternative embodiments of the present invention include rotation enabled by other elements of the tool bit 12 rotating relative the mounting block pocket 14. For example, in an alternative embodiment the bit head 18 is free to rotate about the shank 16 such that the axis of rotation W of the tooth 20 is defined by the rotation of the bit head 18 relative to the shank 16. In either case, the preferred offset between the tooth axis e and the axis of rotation W of the tooth 20 arises from the offset between the crown axis b and the

shoulder axis c, wherein the shoulder axis c and shank axis x are coaxial. However, as will be described in greater detail below, alternative embodiments of the present invention include a variety of configurations to accomplish the offset of the tooth axis e from the axis of rotation W of the tooth 20.

The present invention also encompasses a more efficient method of removing a tool bit 12 from a mounting block pocket 14. A preferred method of removing the tool bit 12 from the mounting block pocket 14 may be described with reference to FIG. 2. As previously mentioned, a preferred embodiment of the present invention includes the clip 24 incorporating the sidewall 68 for grasping. In light of this preferred embodiment, removal of the tool bit 12 from the mounting block pocket 14 includes removing the clip 24 from the clip groove 38 by grasping the sidewall 68 and pulling the clip 24 away from the shank 16. The tool bit 12 can then be removed from the bit pocket 26. In a preferred embodiment, the sidewall 68 and the open end 64 of the clip 24 are opposite one another. Thus, the sidewall 68 is pulled in a direction opposite the open end 64 during clip 24 removal. Further, the tool bit 12 is removed from the mounting block pocket 14 in a direction of the first end 28 of the mounting block pocket passage 26.

As various changes could be made in the above constructions and methods without departing from the scope of the invention as defined in the claims, it is intended that all matter contained in the description or shown in the accompanying drawings be interpreted as illustrative and not in a limiting sense. As such, alternative embodiments are proposed within the scope of the present invention. For example, an alternative embodiment tool bit 212 is illustrated in FIG. 4, and includes a shank 216 and a bit head 218, forming a mouth (hidden in FIG. 4) and maintaining therein a tooth 220. The shank 216, bit head 218, and tooth 220 are highly similar to previous embodiments. However, with the embodiment of FIG. 4, a shank axis x', a shoulder axis c', and a crown axis b' are coaxial. A mouth axis d' and a tooth axis e' are coaxial and offset from the first group of axes x', c', b' such that the tooth axis e' is offset from the shank axis x'. Thus, the tooth axis e' is offset

from an axis of rotation W' of the tooth 220 when the shank 216 is rotatably disposed in a mounting block pocket (not shown). In another exemplary alternative embodiment tool bit not shown, each of the shank axis x', shoulder axis c', crown axis b', mouth axis d' and tooth axis e' are parallel and offset from one another such that the tooth axis e' is offset from the axis of rotation W' of the tooth 220. As demonstrated by the description of these alternative embodiments, the present invention embodies a variety of configurations which result in an offset of a central longitudinal axis of a tooth from an axis of rotation of the tooth relative to a mounting block pocket.

By at least the above stated means, the present invention promotes tooth rotation, resists ejection of a tool bit from a corresponding mounting block, and is amenable to tool bit change-out from the mounting block pocket. In short, the present invention embodies a bit assembly having longer cutting tooth life, operating more reliably, and requiring shorter tool bit change-out times.

Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternate and/or equivalent implementations may be substituted for the specific embodiments shown and described without departing from the scope of the present invention. This application is intended to cover any adaptations or variations of the specific embodiments discussed herein. Therefore, it is intended that this invention be limited only by the claims and the equivalents thereof.